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INFECTIOUS DISEASE RATES IN THE U. S. NAVY, 1980 TO 1995

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Report No. 00-10

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MILITARY MEDICINE, 166, 6:544, 2001

Infectious Disease Rates in the U.S. Navy, 1980 to 1995

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The effect of increasing numbers of women in the U.S. Navy, particularly those aboard Navy ships, on infectious disease risk is unknown. This study examines gender and other demographic differences among all U.S. Navy enlisted personnel in first hospitalizations for infectious diseases from 1980 through 1989 and identifies trends in incidence rates during the extended period from 1980 to 1995. All data were obtained from official personnel and medical records. First hospitalization rates were computed using the Epidemiological Interactive System. Varicella and other viruses and chlamydiae accounted for more than 20,000 hospitalizations among Navy enlisted personnel in the 1980s. In 7 of the 12 categories of common infectious diseases, women's rates were higher than those for men, particularly for viral meningitis, herpes simplex, syphilis, gonococcal disease, and candidiasis. An excess of certain common infectious diseases among women and nonwhite ethnic groups emphasizes the need for continuing education and surveillance in these populations.

Introduction

Knowledge of the epidemiology of infectious and parasitic diseases in the Navy is important for health care planning and for a better understanding of their cause, the effects of new treatments and prophylactic measures, and the prevention of high-risk exposures and future outbreaks. Navy personnel are exposed to a unique variety of risk factors because of crowded, confined living conditions aboard ships and in barracks and contact with numerous unusual infectious agents potentially encountered in foreign ports while on worldwide duty assignments. Historically, infectious disease outbreaks have resulted in severe degradation of combat readiness and enormous costs in terms of health care costs and manpower loss, sometimes proving decisive in the success or failure of military operations. Modern medicine and technology have greatly reduced the threat of such catastrophic effects, but a range of threats remains for naval personnel because of the ubiquitous nature of respiratory and intestinal infectious agents in many naval duty settings.[1-8]

The large increase in the number of women serving in the Navy has raised questions concerning the effect of infectious disease risks on women's health in recent years, particularly aboard Navy ships.[9] Generally, Navy women have higher rates of first hospitalization for infectious diseases than Navy men. Between 1970 and 1972, the annual first hospitalization rate for infectious and parasitic diseases in women was more than four times as high as the rate in men.[10] In later years, this wide difference diminished considerably, but a difference has persisted for a number of such diagnoses. The present study will update these observations and present more detailed information about gender and demographic differences.

Methods

Data for this study were extracted from the Career History Archival Medical and Personnel System (CHAMPS) database created and maintained by the Naval Health Research Center, San Diego, California.[11] This data file is composed of six separate databases containing medical and career history information for all Navy and Marine Corps personnel. Data for Navy enlisted personnel extend from January 1, 1965, to the present. The data were compiled from four medical databases supplied by the Naval Medical Data Services Center (now the Naval Medical Information Management Center) in Bethesda, Maryland. These were hospitalization, medical board, physical evaluation board, and death records. Also, data were compiled from personnel record extracts and monthly extract tapes reflecting important changes in military status (e.g., promotions, demotions, unauthorized absences/desertions, changes in duty station and occupation, and type of discharge). Data elements from all files were combined and organized in chronological order by date and type of event. The database currently has more than 5 million members and tracks each member from entry into service until discharge.

Cases for most analyses in this study included all Navy enlisted personnel with first hospitalizations for infectious and parasitic diseases from 1980 through 1989 (N = 33,334 first hospitalizations). Beginning in 1990, inpatient admission reports were available in CHAMPS only for shore-based medical treatment facilities, including the major U.S. and overseas Navy medical centers in Bethesda, San Diego, Portsmouth, Virginia, and elsewhere. The most recent data available from shore facilities extended through 1995. Therefore, rates of selected infectious diseases also were calculated for shore facilities during the entire period (1980–1995). Infectious and parasitic diseases were identified using three-digit International Classification of Diseases, Ninth Revision (ICD-9), diagnostic categories.[12] These diagnostic categories are used by the Department of Defense for disease classification. Preliminary analyses determined disease categories that had fewer than 1 new case per 100,000 person-years. These categories were omitted from subsequent analyses.

Diagnoses were made by physicians, usually at naval hospitals, at the time of discharge from the hospital and usually after a period of observation and diagnostic testing. All information used in the study was from official personnel and medical records.

First hospitalization rates were computed using the Epidemiological Interactive System (EPISYS), a computerized program that permits rapid access to and analyses of CHAMPS epidemiological data. EPISYS currently contains demographic, occupa-

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The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Navy, the Department of Defense, or the U.S. Government.

This manuscript was received for review in July 2000 and was accepted for publication in September 2000.

tional, duty assignment, and hospitalization data for all Navy enlisted personnel on active duty from January 1980 through December 1997. Denominators used by EPISYS were person-years, calculated by a method described elsewhere.[13] Individual year denominators used for calculating rates from 1980 to 1989 are available from the authors. Average annual denominators (person-years of exposure) for demographic and calendar year subgroups are listed in Table I.[13].

Results

Specific three-digit disease categories were organized by type of disease as shown in the ICD-9 manual.[12] This listing by type is reflected in Table II. Rates are shown only where they exceeded 1 case per 100,000 person years. A large number of disease categories had zero or few cases, so further analysis was not performed on these. The category with the most cases was "viral diseases with exanthem" in which varicella (chickenpox) was the most common. Several categories of infectious or parasitic diseases had no more than 1 case per 100,000 person-years and are not included in this report. Hospitalized incidence rates for diseases with first hospitalization rates of 1 per 100,000 or higher are shown in Table II. Rates varied from 1.2 per 100,000 (typhoid/paratyphoid, meningococcal infection, and neurosyphilis) to 133.9 per 100,000 (chickenpox).

Incidence rates of first hospitalization for the most common infectious diseases were examined by sex, race, and age with the following results.

Chickenpox

Rates were highest over all sex-race combinations for the 17 to 19-year age group. This would suggest that many of these infections occurred during recruit training. Male blacks had the highest rate at ages 17 to 19 years, but other race males had generally higher rates in the remainder of the age ranges. Other sex-race subgroups were homogeneous in first hospitalization rates according to age.

Viral Hepatitis

Rates at ages 17 to 19 years were not high for any subgroup. The highest rate was for other race males at age 20 to 21 years.

TABLE I

AVERAGE ANNUAL DENOMINATORS

Total Navy enlisted personnel	4,997,151
Sex	
Men	4,577,138
Women	420,012
Race	
White	3,979,524
Black	686,550
Other	331,077
Age in years	
17–19	619,767
20–21	979,808
22–24	1,117,966
25–29	1,054,109
30–34	605,402
35–39	410,979
>39	211,620

Rates generally increased during the middle-age range, particularly for black males. Rates were lower for all subgroups after age 29 years.

Infectious Mononucleosis

White women had a much higher rate at ages 17 to 19 years than other subgroups; white men also had an increased rate at age 20 to 21 years. White men and women generally had higher rates than other subgroups. Other sex-race combinations had homogeneous rates in other age categories.

Streptococcal Sore Throat

White women had a much higher first hospitalization rate at ages 17 to 19 years than other groups, although the other groups also had increased rates in this age group. Rates were stable and homogeneous in older age groups, with the 39-years and older age group having the lowest rates.

Intestinal Infections Attributable to Other Organisms and Ill-Defined Intestinal Infections Combined

This category includes a number of specific bacterial infections (food poisoning), including *Escterichia coli*, infectious colitis, and infectious diarrhea. Rates were much higher for women than for men except in the 39-years and older age group. The highest rates were in the 17 to 21-year age range for women. Rates for men tended to be relatively low and homogeneous in all age groups.

Other Diseases Attributable to Viruses and Chlamydiae and Viral and Chlamydial Infection in Conditions Classified Elsewhere and of Unspecified Site

Rates were much higher for women than for men in all age groups except the oldest. The highest rates were seen for women ages 17 to 21 years. Rates for men were homogeneous according to race and were slightly lower in the oldest age groups.

Demographic differences for other selected diseases can be briefly summarized as follows.

Pulmonary Tuberculosis

The incidence rate was higher for men than for women. The rate for Other race was much higher than for white and black racial groups. Also, cases tended to be among older individuals than cases of any other infectious disease.

Viral Meningitis

Women had more than double the rate than men. The white and black racial categories had higher rates than the Other race category. The highest rate occurred in the 25 to 29-year age group.

Herpes Simplex

The first hospitalization rate was nine times higher for women than for men. White and black racial groups had higher rates than the Other racial group. Cases tended to fall toward the younger end of the age range.

Measles

The rate was slightly higher for men than for women and higher for whites than for other racial groups. The highest first hospitalization rate was in the 20 to 21-year age group.

TABLE II

HOSPITALIZED INCIDENCE RATES PER 100,000 PERSON-YEARS FOR INFECTIOUS AND PARASITIC DISEASES IN THE U.S. NAVY, 1980 TO 1989

Disease	*N*	Rate[a]
Intestinal infectious diseases		
Salmonella (003)	153	3.1
Food poisoning, other bacterial (005)	153	3.1
Shigellosis (004)	105	2.1
Other protozoal (007)	96	1.9
Amebiasis (006)	87	1.8
Typhoid/paratyphoid (002)	61	1.2
Other infectious organisms (008)	1958	39.2
Ill-defined infections (009)	1217	24.4
Tuberculosis		
Pulmonary tuberculosis (011)	258	5.2
Other bacterial diseases		
Streptococcal sore throat (034)	1294	25.9
Septicemia (038)	212	4.2
Meningococcal infection (036)	64	1.2
Bacterial infection of other or unspecified site (041)	1153	23.1
Other non-arthropod-borne viral infection of the central nervous system		
Viral meningitis (047)	618	12.4
Viral diseases with exanthem		
Chickenpox (052)	6690	133.9
Herpes simplex (054)	602	12.1
Measles (055)	254	5.1
Herpes zoster (053)	228	4.6
Other viral exanthemata (057)	435	8.7
Other diseases attributable to viruses and chlamydiae		
Viral hepatitis (070)	3310	66.2
Infectious mononucleosis (075)	3198	64.0
Mumps (072)	297	5.9
Conjunctivitis (077)	137	2.7
Other diseases attributable to viruses and chlamydiae (078)	1848	37.0
Unspecified viral and chlamydial infections (079)	3711	74.3
Rickettsiosis and other arthropod-borne diseases		
Malaria (084)	67	1.3
Syphilis and other venereal diseases		
Gonococcal infections (098)	599	12.0
Early syphilis (091)	582	11.6
Other and unspecified syphilis (097)	192	3.8
Neurosyphilis (094)	59	1.2
Other venereal diseases (099)	308	6.2
Mycoses		
Dermatophytosis (110)	974	19.5
Candidiasis (112)	241	4.8
Other dermatomycosis (111)	181	3.6
Other infectious and parasitic diseases		
Sarcoidosis (135)	350	7.0
Trichomoniasis (131)	142	2.8
Acariasis (133)	78	1.5
Other infestation (134)	87	1.6
Other and unspecified infectious diseases (136)	95	1.9

ICD-9 codes are in parentheses. No diseases in the following categories had more than 1 new case per 100,000 person-years: zoonotic bacterial diseases, arthropod-borne viral diseases, other spirochetal diseases, helminthiases, and late effects of infectious and parasitic diseases.

[a] The number of new cases (first hospitalizations) per 100,000 person-years.

Other Exanthema

The rate was slightly higher for men than for women and higher for whites than for other racial groups. The rate was highest in the youngest age category.

Mumps

Women had a marginally higher rate than men, and the Other race category had a higher rate than whites or blacks. The youngest age category (17–19 years) had a much higher rate than the other age categories.

Early Syphilis

The rate for women was more than double that for men, and the rate for blacks was much higher than that for the other racial groups. Individuals aged 20 to 24 years had the highest rates.

Gonococcal Disease

The rate for women was three times higher than that for men, and the rate for blacks was much higher than that for other racial groups. The highest rates were seen in the youngest age groups.

Other Venereal Disease

The rate for men was markedly higher than that for women. The rate for blacks was higher than the rate for other racial groups.

Dermatophytosis

The rate was much higher for men than for women and lower for the Other race group than for the white and black groups. Rates were quite stable across age categories but highest in the youngest and oldest groups.

Candidiasis

The rate for blacks was higher than for other racial groups. Rates were constant across age groups.

Sarcoidosis

Women had a slightly higher rate than men, and blacks had almost 10 times the rate of the other racial groups. Rates tended to be constant across age groups, except for the 20 to 21-year group, which had a lower rate.

Changes in first hospitalization rates were then examined across the 1980s for the most common diseases in the entire Navy enlisted population (data not shown but available from the authors). Rates for chickenpox increased precipitously during the decade: almost 10-fold from 1980 to 1988–1989. Rates for viral hepatitis declined slowly and steadily from 1980 through 1989. Rates for infectious mononucleosis were stable during the decade. Rates for other and ill-defined intestinal infections declined from 1980 through 1982, increased during 1985, and decreased again from 1986 through 1989. Rates for other viruses or chlamydiae classified elsewhere or with unspecified site declined from 1980 through 1984, increased during 1985 and 1986, declined during 1987, and plateaued in 1988 and 1989.

Changes in incidence rates over time for other specific infectious diseases also were examined. There was a downward trend

in pulmonary tuberculosis rates during the entire decade. There was a clearly upward trend in viral meningitis; rates more than doubled. Rates for herpes simplex were stable through 1985 but increased moderately from 1986 through 1989. Rates for measles were relatively high in 1980 and 1984 but much lower in other years, including zero in 1989. The rate for other exanthema was high in 1980 but declined sharply during the decade. The mumps rate was very low early in the decade but increased considerably toward the end of the decade. Rates were approximately level during the decade for early syphilis, other venereal disease, and sarcoidosis. Rates for gonococcal disease declined slightly and then were stable. Rates for dermatophytosis were stable until 1985, then increased steadily through 1989. Rates for candidiasis increased steadily and had increased almost 4-fold by 1989.

For summary comparisons of demographic and temporal changes in rates during the decade, diseases were grouped into three broad types: viral, bacterial, and sexually transmitted (Fig. 1). Viral diseases constituted, by far, the largest number of first hospitalizations. There were 21,346 first hospitalizations among men and 2,702 first hospitalizations among women.

The number of first hospitalizations for bacterial illnesses was 4,402 (3,597 men or 78.6 per 100,000 and 805 women or 191.7 per 100,000). The rate for whites was slightly higher than the rates for blacks and other races. The number of hospitalized sexually transmitted disease cases was 1,900 (1,519 men for a rate of 33.2 per 100,000 person-years, and 381 women for a rate of 90.7 per 100,000 person-years). Rates for men remained stable from 1980 to 1989, but rates for women, after declining somewhat from 1980 through 1984 (from 105.2 to 52.5), increased sharply from 1985 through 1989 (to 135.7 in 1989).

Trends in hospital admissions ashore also were evaluated during the entire period (1980–1995) in shore-based facilities only. The epidemic of varicella that peaked from 1987 to 1989 ended by 1992, when rates returned to endemic levels of approximately 80 per 100,000 person-years (Fig. 2). Viral hepatitis (A, B, C, and other) first hospitalization rates declined from approximately 37 per 100,000 person-years in 1990 to approximately 17 per 100,000 person-years in 1995. When the rates for hepatitis A and hepatitis B were examined separately, comparable decreases during this period were noted for both types. Rates of tuberculosis and gonorrhea also declined from 1990 to 1995, whereas syphilis continued its long-term decline, reaching a level of approximately 0.5 per 100,000 in 1994–1995 (Fig. 3). Meningococcal meningitis rates varied between 0 and 1.4 from 1990 to 1995.

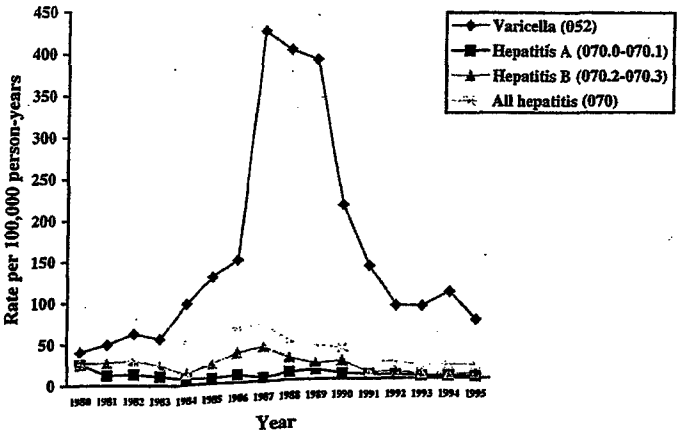

Fig. 2.

Discussion

Varicella and other viruses and chlamydiae accounted for more than 20,000 hospitalizations among Navy enlisted personnel in the 1980s. In 7 of the 12 categories of common infectious diseases, women's rates were higher than those for men. The female excess was particularly evident for meningitis, herpes simplex, early syphilis, gonococcal infections, and candidiasis. These results are similar to those reported for Navy women in an earlier study.[1] The observed rates of first hospitalization for sexually transmitted diseases emphasize the need for further education in this population. First hospitalization rates also varied greatly by ethnic and age groups, with whites having more than double the rate of measles and other viral exanthema; blacks having the highest rates of syphilis, venereal diseases, and sarcoidosis; and individuals of other ethnic groups having the highest rates of pulmonary tuberculosis and mumps. The much greater incidence of syphilis among blacks is consistent with data reported from the Navy and Marine Corps Disease Alert Reporting system (DAR).[14] On the other hand, the higher rate for women found in the present study is in contrast

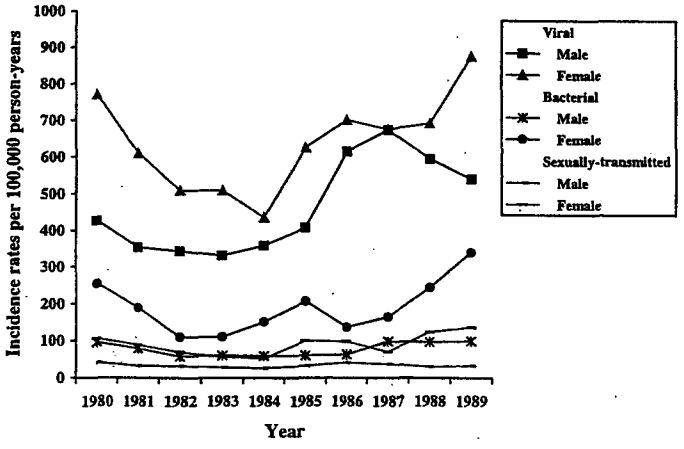

Fig. 1.

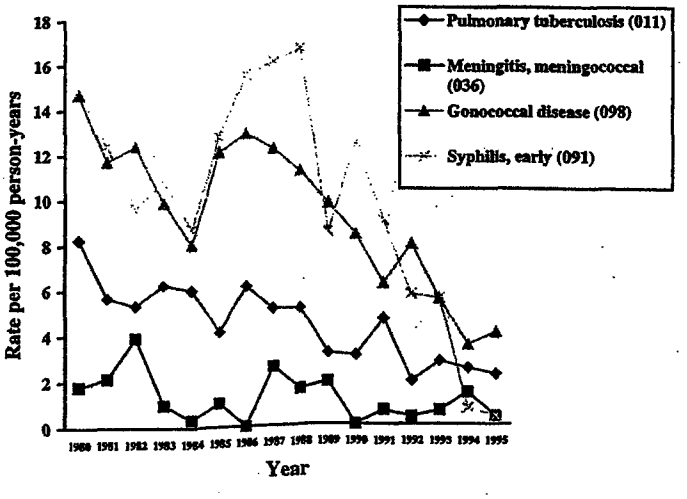

Fig. 3.

to findings from the DAR. One possible explanation might be underreporting of female cases to the DAR.

In general, the 1980s were marked by downward trends in many infectious diseases, by relatively stable rates of sexually transmitted diseases, and by brief epidemic periods of measles, mumps, and varicella. The young age of personnel with these latter diseases suggests that many infections occurred during recruit training. This is consistent with findings of high rates of seronegativity for mumps, measles, and varicella among U.S. Navy and Marine Corps recruits.[4] The higher rates of chickenpox among young black men in the present study suggest a greater proportion of susceptible individuals or poorer immunization coverage in this population. Rural blacks may be less exposed to the varicella zoster virus, because varicella epidemics are less frequent in isolated areas than in urban areas. It is unknown whether the cases occurred in blacks of primarily rural origin; however, urban African-American children also have lower rates of immunization.[15] Although rates in black women were considerably lower than in black men, they were three times as high as in white women. This is also consistent with poorer immunization coverage in blacks.[15,16]

The hospitalized incidence rate of viral meningitis during the 1980s was 12.4 per 100,000 person-years, which was two to four times higher than the rate reported to the Centers for Disease Control and Prevention (CDC) from 1980 through 1994. The rate of viral meningitis based on passive reporting to the CDC through the notifiable disease system varied between 3 and 6 per 100,000 population per year.[17] In contrast, a study based on medical records review in Olmstead County, Minnesota, reported an incidence rate of 10.9 per 100,000 person-years,[18] which was closer to the Navy rate. The slightly higher rate in the present study compared with Olmstead County may be attributable to the greater representation in the Navy of persons in the age range in which incidence rates were highest (20–34 years) and possibly to closer living conditions in the Navy shipboard population.

Active pulmonary tuberculosis during the 1980s was uncommon overall in the Navy population, but there were important ethnic differences in incidence rates of hospitalized disease. The relatively high rate in individuals of races other than white or black suggests that more frequent screening for early infection of individuals in the other ethnic group may be warranted to identify those with early tuberculosis infections before they advance to active pulmonary tuberculosis. In the Navy, these individuals were mainly of Pacific Island (including Philippine) and Asian heritage.

The higher rate of measles in Navy men than women was somewhat unexpected and should be examined further. The highest incidence rate was in the 20- to 21-year age group, which also was unexpected because most infectious diseases are most common in the youngest age group (17–19 years).

Unlike most infectious diseases, mumps increased from 1984 through 1989, especially in the years 1986 to 1989. It is possible that the increase in mumps may represent demographic changes or a greater tendency to hospitalize mumps patients in more recent years, but the association of the increase with the steep increase in human immunodeficiency virus infections during the same period may warrant further investigation. The increase in mumps rates and the concurrent decline in measles also may reflect differences in vaccination rates with the monovalent measles versus the trivalent measles-mumps-rubella vaccines.

Several investigators have examined the issue of effective vaccination in the military. In a study examining the cost-effectiveness of an immunization program for mumps in the U.S. Army, Arday et al.[5] concluded that Army mumps rates would have to more than double from 1986 levels for a blanket immunization program to be cost-effective. Although cost figures were not collected in the present study, it should be noted that Navy mumps rates tripled between 1986 and 1989, and it is likely that such an immunization program would be cost-effective under such circumstances, particularly if targeted to the recruit population. It also has been suggested that varicella vaccination may prevent more than 7,000 hospital-bed days[19] annually in the military. A proposed strategy would be to serologically test personnel with a negative history and vaccinate those without protective antibodies.[2,20] Although it was found not to be cost-effective among Army recruits,[21] this strategy was found to reduce the incidence of clinical rubella in U.S. Air Force trainees.[22]

Data that were available from shore-based facilities from 1980 to 1995 indicated that trends in these facilities were similar to those in the entire Navy (including medical treatment facilities aboard ships or in temporary camps). The majority of inpatient hospital admissions are to shore-based facilities, and patients with serious diseases admitted to the hospital aboard ships or in forward areas generally are transferred to shore-based hospitals for definitive treatment and convalescence.

Analysis of trends for selected infectious diseases from 1990 to 1995 revealed a steady decline in rates of hospitalization. The varicella epidemic of 1987 to 1989, which was particularly associated with recruits and junior ranks[2,4,19] and was present in the Army as well as the Navy,[2] did not recur. The decline in hepatitis (A, B, and total) was similar to general declines in incidence of cases of hepatitis A and B reported to the CDC.[23] The minor peak in rates of meningococcal disease in 1994, followed by a rapid decline, was suggestive of a possible very limited epidemic that year. In contrast, the CDC reported that cases of meningococcal disease per 100,000 population increased in 1994 but did not decline in 1995.[23]

A limitation of the present study is that individuals with infectious diseases that are usually less serious, such as influenza, are generally not hospitalized and were not part of this analysis. Their effect on military readiness may be substantial. The primary strength of this study is the examination of the entire spectrum of infectious disease categories with a common methodology in a 10-year longitudinal analysis. This procedure has permitted comparisons in both rates and demographic risk factors, allowing better identification and monitoring of high-risk groups.

Acknowledgments

We gratefully acknowledge Martin White, Milan Miller, and Rae Jackson for their helpful contributions to this report. Report 00-10 was supported by the Office of Naval Research, Arlington, Virginia, Department of the Navy, under work unit number 63706N M0095.001-6706.

REPORT DOCUMENTATION PAGE

1. Report Date (DD MM YY)	2. Report Type	3. DATES COVERED (from - to)
October 1999	Final	1980 through 1989

4. TITLE AND SUBTITLE
Infectious Disease Rates in the U. S. Navy, 1980 to 1995

5a. Contract Number:
5b. Grant Number:
5c. Program Element: 63706N
5d. Project Number: M0095
5e. Task Number: 001
5f. Work Unit Number: 6706

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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P.O. Box 85122
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8. SPONSORING/MONITORING AGENCY NAMES(S) AND ADDRESS(ES)
Office of Naval Research
800 North Quincy St
Arlington, VA 22217-5660

9. PERFORMING ORGANIZATION REPORT NUMBER
Report No. 00-10

10. Sponsor/Monitor's Acronyms(s)
ONR

11. Sponsor/Monitor's Report Number(s)

12 DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES
Published in Military Medicine, 2001, 166(6), 544-549

14. ABSTRACT (maximum 200 words)

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15. SUBJECT TERMS
infectious disease rates, sexually transmitted diseases, varicella, epidemiology, Navy

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b.ABSTRACT	b. THIS PAGE			Commanding Officer
UNCL	UNCL	UNCL	UNCL	6	19b. TELEPHONE NUMBER (INCLUDING AREA CODE) COMM/DSN: (619) 553-8429